Letters to the Editor.

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The Natural History of Man.

IN an article on "New Experiments on the Inheritance of Somatogenic Modifications," in NATURE of February 3 (p. 742), Prof. Arthur Dendy writes: "It has long been suspected that the problem of the transmission from parent to offspring of somatogenic modifications ('acquired characters') might be solved more readily by physiological experiments directly involving the complex metabolism of the body than by crude surgical operations, such as the amputation of limbs." He proceeds to tell us of experiments which are thought to demonstrate that when certain toxic substances are injected into the blood of pregnant rabbits a deterioration of the eyes of the offspring sets in, which is transmitted and increased generation after generation.

Now examine the other side of the shield. Let us use a little of the evidence from associated sciences which zoologists and botanists have ignored. It has been said by naturalists that man is a domesticated animal, meaning, probably, that man is a social animal like ants and bees. Man is a typical wild animal, living under an enormous variety of conditions, which have become perfectly natural to him. At any rate, he is not under artificial selection. Again, it has been said by opponents of Darwin that no one has seen natural selection in operation, and that, therefore, its existence is a pure guess; and by yet others, supporters of Darwin, that man has escaped from selection. As a fact, every man, except the biologist as such, has seen natural selection in full blast, and, so far from having escaped from selection, man is everywhere stringently selected in a glaringly obvious way. Indeed, since we are able to follow the career of men with a completeness that is unique in the animal world, man is the only animal in which natural selection can be observed and its consequences traced to the last little detail. Apart from each man's personal experience and a voluminous literature, it is the principal function of all Departments of Public Health to collect precise statistical information bearing on this very subject.

Man is the prey of a multitude of living microbic species, which have become parasitic on him, and attack him in all sorts of ways and with every degree of stringency of selection. It is common knowledge that men vary in their powers of resisting various microbic diseases, and that these powers of resistance tend to "run in families" (*i.e.* are inheritable), as is conspicuously the case in tuberculosis—a fact which is still better observable when we compare men of different races; for example, West African negroes and Englishmen in respect to tuberculosis and malaria. Again, it is common knowledge that powers of resisting any disease do not necessarily imply powers of resisting another disease.

Here, then, is natural selection indubitably manifest in the only wild species in which observation of its operations is possible. What is the effect on races? Does any change result? If so, does it accord with Lamarckian or Darwinian doctrine? It may be laid down as a rule to which there is no exception that *every human race is resistant to every prevalent and lethal human disease in proportion to the length and severity of its past experience of that disease.* Here, then, is evolution indubitably manifest as a consequence of natural selection.

But this recital gives no conception of the fidelity with which evolution follows selection. Not only does selection by any disease cause evolution against itself alone, but there are also two main types of diseases which select in unlike ways and cause extraordinarily unlike racial effects. In one group (*e.g.* measles and smallpox) the microbes flood the victim with toxins, soaking even his germ-cells. He dies; or, reacting against these toxins, recovers within a definite period, the duration of which, speaking generally, varies with the abundance and virulence of the toxins. Recovery implies "acquired" immunity, which is often of lifelong duration, and is simply a "use-acquirement"—a response to functional activity. The individual has become "used to," or trained by, the toxins through some physiological process, just as he becomes used to tobacco, or exertion, or the performance of difficult and complex thinking. Practically everyone is susceptible to this class of disease. As a rule, therefore, the survivors are not those who resist illness, but those who recover from it. In the other group (*e.g.* tuberculosis and leprosy) the microbes retain their poisons within themselves, and the illnesses caused by them are usually prolonged and of indefinite duration. The survivors are, as a rule, not those who recover from illness, but those who resist it, *i.e.* those who are "innately" immune. In this class of disease individuals vary greatly in resisting power. Thus, in tuberculosis, there are those who seem quite immune under the worst conditions, those who fall ill under bad conditions but recover when the conditions are improved, those who die after lingering illness, and those who perish swiftly and, as a rule, in early life. Here there is no "acquired" immunity; whoever is infected suffers nothing but injury.

Plainly in disease we have on a vast scale just those "physiological experiments directly involving the complex metabolism of the body" concerning which Prof. Dendy is so hopeful. If the Lamarckian doctrine be true, diseases of the measles type should, by the "transmission of acquired immunity," render the race less and less susceptible to infection until it acquires "innate" immunity; on the other hand, diseases of the tuberculosis type should enfeeble the race by the accumulation of injury until at last it perished. But nothing of this has happened. On the contrary, racial changes have followed precisely contrary lines, those of natural selection. Thus Englishmen who have long been exposed to measles are fully as susceptible to infection as Polynesians, but recover from illness more easily and frequently; whereas races which have long been exposed to tuberculosis (*e.g.* Jews) resist infection much more stoutly than those that have been less exposed (*e.g.* American Indians). The diseases of animals and plants (*e.g.* in the fly districts of Africa) tell the same story, but here natural selection cannot be as closely studied as in the case of man. We see only the consequent evolution. Now compare as to volume and duration the minutely studied and easily observed physiological experiments of Nature which Prof. Dendy ignores with those to which he pins his faith. Obviously, if anyone did establish that the injection of a toxin caused hereditary degeneration, he would discover, not a rule, but one of the rarest exceptions in Nature.

In order to demonstrate the importance of disease selection, it is worth while to pursue this subject a little further. Doubtless there have been many great human migrations, but two especially are recorded in history—that immense surge of Eastern people which established in their present sites many of the modern races of Europe, and that still vaster overflow which carried the inhabitants of modern Europe to the Western hemisphere. If history teaches any lesson with clearness, it teaches this—that unless conquered peoples are exterminated they invariably absorb or expel the conquerors. Hence the disappearance of the Greek, Roman, Saracenic, Norman, and Turkish governments.

All, or nearly all, human microbic diseases appear to have originated in the Eastern hemisphere, where men first multiplied sufficiently to provide a constant supply of nutriment to the parasites. Myth and history tell first of epidemics. Such diseases as measles suddenly appeared, attacked young and old, and then, having exhausted the food supply, passed to neighbouring populations, leaving behind a human remnant which had acquired immunity. Later, when populations became more dense, the multitudes of new births furnished a perennial supply of food, and enabled many of these diseases (*e.g.* measles and whooping-cough) to become endemic. Epidemic disease, especially if occurring at rare intervals, is always the more terrible; for the old as well as the young are affected, and in consequence the sick are left untended, business is neglected, and famine follows. Many perish who would otherwise have survived. Witness in modern times the fate of many Pacific Islanders. Endemic disease selects more stringently, but more cleanly; the old who have acquired immunity tend the young, and only the less resistant die. Some maladies, especially those which are insect-borne (*e.g.* malaria), are confined to localities, but most others are, in varying degrees, "crowd" diseases. Thus in England no one escapes frequent contact with measles and tuberculosis, which cause illness unless the individual be immune, and death unless he be resistant. All such diseases tend to become endemic as the crowd thickens. We speak of the deadly climate of West Africa; but that of England is even more deadly to visitors from thinly scattered tribes (*e.g.* nearly all savages). There is no evidence that any human race is mentally unfitted for civilisation, but there is the clearest evidence that, physically, only those races are capable of it which have evolved in response to that slowly increasing stringency of selection which occurs when populations gradually become more dense.

Of old the sword exterminated the conquered and dug deep the foundations of permanent empires. With advancing civilisation and the cessation of deliberate extermination, it lost its power. But when Columbus ended the long separation between East and West he bore weapons more deadly than the sword. Except malaria he met no considerable diseases, but the microbes of the East found virgin soil. Thereupon commenced the greatest event and tragedy in human history. The races of one half of the world began to replace those of the other half. As in the ancient Eastern world, measles, small-pox, and other diseases of definite duration swept the continent in vast epidemics. They left behind them an immune remnant. But tuberculosis, endemic from the first, owing to its long duration in the individual, exterminated wherever the conditions favoured its spread. Spain and Portugal, then powerful maritime States, and first in the field, elbowed the weaker British and French into the seemingly inhospitable North. But, while the tropics were defended by malaria, nothing protected the North, where British and French settlers poured into the vast void created by imported diseases. The former won the battle of Quebec. French immigration ceased, and all North America fell into the grasp of the Anglo-Saxon. Later the microbes created, and the Anglo-Saxons are now filling, another void in Australasia. Thus our race won a place in the sun, and to-day has more room for expansion than any other race. In actual truth, even if soldiers, sailors, and settlers founded the British Empire, it was the microbes that established it on enduring foundations. Germany began her war a century too late. If history repeats itself, the Anglo-Saxons are sure to lose their Eastern conquests, where every European settlement is surrounded by a flourishing native quarter; but seemingly they are rooted for ever in the West, where the natives can exist only in the wilds. Every travelling disease has reached almost its limits, and therefore diseases, like the sword, are losing their power of founding permanent empires. The period of the great human migrations is drawing to an end.

The story of the evolution against narcotics is similar. For example, individuals differ greatly in their degree of susceptibility to the charm of alcohol. Some men swiftly acquire an intense craving for deep indulgence in it; but most of us are temperate without effort or very little effort. In other words, we have no great susceptibility. Speaking generally, moderate drinkers are not those who resist temptation, but those who are not greatly tempted. Habitual heavy drinkers are always much tempted. Alcohol is a poison which especially affects the habitual heavy drinker, not only killing the worst cases, but also making many more susceptible to numerous ills—for instance, tuberculosis. Every race (*e.g.* Jew, Greek, Italian, South German, South French, Spanish, Portuguese, West African) which is now temperate in the presence of abundant supplies of alcohol was anciently drunken. That is, every race is insusceptible to the charm of alcohol in proportion to the length and severity of its past experience of it. Precisely the same is true of opium. Natives of India take it in moderation; the Chinese in greater excess, but in less excess than formerly; while Burmans and Australian blacks indulge immoderately and perish swiftly. Nature's unfailing plan of temperance reform is to remove the heavy drinker. The human plan is to remove drink and leave the potential drinker to multiply. But yeast and sugar cannot be eliminated, and human, unlike natural, laws are sometimes disobeyed, and are never immutable.

I have tried to sketch a little of the natural history of man, concerning which so little has been written, but which, even politically, is so much more important than his voluminously described political history. The evidence, none of which I think is disputable, is derived mainly from medical and historical sources, but the problems which arise are biological. They are too big for doctors and historians, who are mere specialists. Meanwhile what has biology done to establish the actuality of natural selection? She has measured some frozen sparrows, she has suffocated some crabs, and she is now conducting some "physiological experiments" to ascertain whether "acquired" characters are "transmissible." Some of her eminent professors have declared that natural selection is a myth, and the pulpits of the contemners of science are filled with acclamations.

But it is mind which presents biology with the greatest of her problems, tasks, and opportunities. Man is the educable animal. On the mental training of his young depends the intellectual status of the individual and the social status of the community. Men of science, especially biologists, frequently urge scientific education. What is it? It implies, I conceive, the supplying of information which is likely to be useful, intellectually or materially, in such a manner that the pupil is left a skilful, unbiassed thinker with an open, receptive, reflective habit of mind. So far as possible he is taught, not what to think, but *how* to think. In the opposite type of education an endeavour is made to close the mind—to bias, to stupefy, to induce an artificial incapacity to profit from fresh experience, to hold beliefs even in the face of conclusive evidence; in brief, to teach the pupil *what* to think, not how to think. Compare, as products of these opposite types of mental training, Darwin and Huxley with devout Mohammedan and Hindu ecclesiastics. The evidence in favour of scientific education is enormous, decisive, indisputable, but it lies outside the sphere of botany and zoology, in psychology and history. By whatever rational standards we judge human communities—material or intellectual progress, efficiency in peace and war, wealth, enterprise, energy, the production of great thinkers and men of action, civil war, brigandage, murder and other crimes, and so on—we find invariably that the societies the mental training of which has most nearly approached the scientific ideal are the superior. Compare the results of the mental training given by Socrates and his fellows to the ancient Greeks with that given by the Russian popes to their victims. Many nations (*e.g.* the Romans) have fallen because a change for the worse in mental training left descendants too inefficient to preserve that which better-trained ancestors had secured. Many nations (*e.g.* after the Reformation) have arisen because improved mental training enabled them to surpass competitors. Consider the late war and how completely the more biassed peoples have been smashed. But this is a subject too vast for present consideration; I have tried to deal with it elsewhere.[1]

I may be right or wrong as to the conclusions I have reached, but clearly the evidence and problems I have instanced exist. Clearly they are matters for biology, although they have been neglected by her.

Academic biology is of little account in the world. The hobby of some naturalists who use not a tittle of the evidence available, she possesses next to no established truth. Her few students are engaged in unending disputes, all of which are consequent on a misuse of words or a neglect of crucial testing. Her indefensible terminology separates her from a host of subsidiary sciences. But a biology clarified and simplified by a precise terminology, and in possession of a classification of characters similar to that employed in other studies, might easily become the queen of sciences. A few wide generalisations accepted by everyone would then replace the present chaos of opinions, and provide a basis for work of practical utility. The use of evidence from other studies would make their students her own. So strengthened, she would become a power in the land, and perhaps lay the foundations of that golden age of science and human wisdom and well-being of which we all dream.

Surely there are biologists who perceive that the failure to establish truth can have no cause other than lack of right scientific method, and who are prepared to substitute the method of discussion which has created other sciences for that of controversy which has wrecked biology.

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[1] *Vide* "Prevention of Venereal Disease," reviewed in NATURE, April 14.

Magnetic Double Refraction of Smokes.

THE interesting discovery recorded by Sig. Tieri in NATURE of August 18, p. 778, that the fumes from an iron arc can, when subjected to the action of a magnetic field, rotate the plane of polarised light, is in close accord with the view of the structure of such fumes advanced by Prof. Elihu Thomson in his recent letters to NATURE, and agrees also with the observation of Mr. Speakman and myself (see NATURE, June 23, p. 520; and July 14, p. 619).

Prof. Thomson explains the sudden enhanced luminosity of the light scattered by the iron oxide smoke when the magnetic field is applied by the particles arranging themselves along the lines of force. For this structure to be effective the particles cannot be spherical, but must consist of rods or chains, for only then would the intensity of the reflected or scattered light vary with "end on" or "length on" incidence. This was confirmed by a microscopic examination of the iron oxide fume, which showed the particles to consist of short strings or chains of roundish beads not touching one another.

The experience of Mr. Speakman and myself is that the fumes from metallic arcs in air undergo rapid changes with time. The minute particles produced at first by condensation of vapour aggregate together to form complexes, which often show a definite chain-like structure when examined after deposition on a slide, but in the air are continually altering their form under molecular bombardment.

Now it seems likely that if by magnetic or electric forces the small chains or strings can be made to space themselves with their axes all in one direction, not only will the effect described by Prof. Thomson be produced, but a beam of polarised light traversing the fume at right angles to the field of force would suffer rotation provided that the plane of polarisation is neither parallel nor at right angles to the longer axes of the small chains. This is just what Sig. Tieri finds, and it might be expected further, if the above explanation is the correct one, that the magnetic double refraction would vary with the age of the smoke and its method of production. The bluish-coloured smoke found by Prof. Thomson to accompany the yellow fumes from the iron arc, and which did not exhibit the magneto-optical effect, consisted probably of single particles, and would be unlikely to show magnetic double refraction. It corresponds with the initial stage of the oxide clouds we have studied before agglomeration has had time to occur.

This striking behaviour of iron oxide dispersed in air discovered by Sig. Tieri exhibits a close parallel to the behaviour of the same substance dispersed in water. Cotton and Mouton and others have investigated the magnetic double refraction of iron oxide hydrosol, and they ascribe the effect to the orientation of rod-shaped or lamellar ultramicrons. Further, the magnitude of the effect was found to increase as the colloid became coarser.

A continuation of the work commenced by Sig. Tieri may well lead to much interesting information on the form of the particles in smokes.

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Eton College, Windsor, August 21.

The Contractile Vacuole.

IN connection with previous correspondence on the mode of production of the contractile vacuole in Protozoa (NATURE, vol. cvi., pp. 343, 376, 441), I find that it is, in point of fact, Prof. Marcus Hartog to whom the credit of the osmotic view is to be given. In a communication to the British Association in 1888 (Rep., p. 714) this observer pointed out that, owing to the semi-permeable surface membrane, substances in solution in the protoplasm of these organisms must attract water, which accumulates at a particular spot until it reaches the surface, breaks through the membrane, and escapes. The membrane spontaneously closes up as the distension is relieved. Prof. Hartog shows that if substances such as sugar or potassium nitrate are dissolved in the outer water to a sufficient osmotic concentration, the production of the vacuole ceases. The paper was reprinted in Ann. Mag. Nat. Hist., Sec. 6, vol. iii., p. 64 (1889). The theory was worked out in more detail by Degen (*Bot. Zeit.*, vol. lxiii., abt. 1, 1905), and is explained by Prof. Hartog in his article on Protozoa in the Cambridge Natural History (1906),